STATE OF NEW YORK
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DEPARTMENT OF TRANSPORTATION
WILLIAM C. HENNESSY, Commissioner

1220 WASHINGTON AVE., STATE CAMPUS, ALBANY, NEW YORK 12232

TECHNICAL REPORT 83-2

THE EXPERIMENTAL USE OF FIBEROUS REINFORCED BITUMINOUS CONCRETE

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materials bureau technical services division

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THE EXPERIMENTAL USE OF FIBEROUS REINFORCED BITUMINOUS CONCRETE

Hempstead Turnpike - Route 24
Nassau County - Contract D250009

Prepared by

David C. Whiteley
Civil Engineer I (Materials)

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MATERIALS BUREAU
JAMES J. MURPHY, DIRECTOR

NEW YORK STATE DEPARTMENT OF TRANSPORTATION
1220 WASHINGTON AVENUE, ALBANY, NY 12232

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PREFACE

Reflective cracking in bituminous concrete overlays has been a major concern of this Department for a number of years. A variety of new and experimental materials and techniques designed to control or reduce reflective cracking have been incorporated into various pavement reconditioning and preservation projects with no definite conclusions.

This is a summary of the design and placement of a Fiberous Reinforced Bituminous Concrete pavement on Hempstead Turnpike (Route 24) near Levittown, Long Island. Polyester fibers, manufactured by the DuPont Company, were used in two standard bituminous concrete pavement overlay mixes at a rate of five (5) pounds per ton of mixture and placed under Contract D250009.

Performance of this Fiberous Reinforced Bituminous Concrete overlay will be monitored throughout its service life to determine if the addition of polyester fibers to a bituminous concrete mixture will eliminate or reduce reflective cracking.

Special appreciation is given to the Department's Region 10 Materials and Construction Project staff for their contribution to this experimental project.

I. INTRODUCTION

Now that asbestos fibers in bituminous concrete paving mixtures are no longer allowed due to potential health hazards, alternative materials are being investigated and evaluated. One of the materials currently under investigation is polyester fibers. Polyester fibers have been used by the Textile industry for several years with no known health related problems. Polyester is a polymerized material, a component of crude oil. Polyester fibers are manufactured through a process called melt spinning and then cut to various lengths.

The significance of adding polyester fibers to bituminous concrete mixtures is to increase the cohesive and tensile properties of the mixture. The objective of placing this type of Fiberous Reinforced Bituminous Concrete mixture over existing pavements is to determine if the addition of the polyester fibers will prevent or reduce the amount of reflective cracking.

The polyester fibers currently under investigation are manufactured by the DuPont Company and supplied by Kapejo Inc. of Wilmington, Del. These polyester fibers are marketed as "Boni-Fibers", a registered tradename of Kapejo Inc. The polyester fibers are available in three different sizes, Type "B" which has a length of 1/4 inch, Type "C" which has a length of 1/50 inch, Type "D" which has a length of ½ inch. All three types have a diameter of 0.00063 inch, and a specific gravity of 1.38. They also have a minimum melting temperature of 480°F and an ignition temperature of 1040°F. Through the suppliers recommendation, Type "B" polyester fibers were incorporated into two standard bituminous concrete mixtures.

The Fiberous Reinforced Bituminous Concrete mixtures were placed on a section of the Hempstead Turnpike, Route 24, located in the towns of Hempstead and Oyster Bay, Long Island. This project, which was constructed under contract D250009, begins at Wantagh Avenue and ends just east of the Seaford-Oyster Bay Expressway interchange. The six lane east-west divided highway has a total width of 35 feet in each direction separated by a 20 foot raised median which incorporates left turn lanes.

The existing pavement was re-constructed in 1957 and is a 10½ inch composite pavement comprised of eight (8) inches of concrete base and 2½ inches of bituminous concrete binder and top courses. Traffic volume on this section is approximately 30,000 vehicles per day.

All three travel lanes in the test section were paved with the fiberous material except for a left turn area at the intersection of Wantagh Avenue.

The Contract specified a two course bituminous concrete overlay to be placed on the existing pavement for a distance of 1.22 miles. The fiberous mixtures were placed on the westbound travel lanes between Wantagh Avenue and Hicksville Road, a distance of 0.43 miles. The surface course in the left turn lane at the intersection of Wantagh Avenue did not contain the polyester fibers. The other left turn lane does. (Refer to Figure 1 for project location).

The test section leveling course specified was Type 7 bituminous concrete reinforced with 0.25 percent polyester fibers. The test section surface course specified was Type 6F high friction (Marshall Design) bituminous concrete reinforced with 0.25 percent polyester fibers. The 0.25 percent polyester fiber content is based on the total batch weight of the bituminous concrete mixture.

The approximate cost of the polyester fibers is $1.05 per pound, which when added to the bituminous concrete mixture at a rate of 0.25 percent, increases the fiberous mixture cost by $5.25 per ton. Also the fiberous mixture required the addition of 0.2 percent asphalt cement. That increased the cost another 0.30 cents per ton. The total increased cost for the fiberous mixture was $5.55 per ton. This was not reflected in the actual bid price, which was only $1.00 per ton more than the non-fiberous mixture.

II. PROJECT PREPARATION

The experimental project specified 385 tons of Type 7 and 616 tons of Type 6F fiberous mixture to be placed within the test section. Type 7 fiberous mixture was used as a truing and leveling course and placed at a nominal compacted thickness of 3/4 inch. In order to maintain curb reveal, this course was tapered to 1/4 inch at the curb line. Type 6F fiberous mixture was used as a surface course and placed at a nominal compacted thickness of 1 inch. (Refer to Figure 2 for a typical section).

The existing bituminous pavement in the project area was generally in fair-to-poor condition. The pavement surface exhibited many areas of distress and severe wear especially in the wheel tracks. This could be attributed to the heavy volume of traffic, which is approximately 30,000 vehicles per day. Region 10 Materials personnel conducted a survey which thoroughly documents the original pavement condition. This pavement survey is on file at the Region 10 Materials office. (Refer to Figure 3 for pictures of the original pavement).

Pavement reflective cracking over and near the joints and deteriorated areas was categorized into three types of repair. (Refer to Figure 4 for Illustration of Repairs).

Type "A" Repair

These are areas where both the concrete foundation and bituminous concrete pavement were structurally sound. No repairs were made to joints and cracks less than 3/8 inch in width. Joints and cracks 3/8 inch and wider were to be cleaned and filled with a bituminous fine graded shim course.

Type "B" Repair

These are areas where the bituminous pavement was deteriorated and the concrete foundation pavement was structurally sound. The deteriorated bituminous pavement was removed and replaced with a dense graded binder course. The existing joint in the concrete foundation was repaired as outlined in Type "A" Repair.

Type "C" Repair

These are areas where both the concrete foundation and the bituminous pavement were completely deteriorated. The deteriorated pavement sections were removed to the subbase and replaced with a dense graded binder course.

Binder course placed in the deteriorated areas was compacted to the existing pavement grade. Of the 42 repair areas in the test section, 40 percent were Type "C" and 60 percent were Type "B".

III. PROJECT CONSTRUCTION

Both Fiberous Reinforced Bituminous Concrete mixtures were batched and mixed in a pugmill type batch plant. The pre-weighed polyester fibers were packaged in plastic bags and placed directly into the pugmill at a rate of 0.25 percent, based on the total weight of the mixture. An additional 15 seconds of dry mixing was needed to insure uniform distribution of the polyester fibers. The asphalt cement content for both types of fiberous mixtures was increased by 0.20 percent. This increase was to insure proper coating of the polyester fibers and resulted in asphalt contents of 6.3 percent for the Type 6F and 6.7 percent for the Type 7. Aggregate gradations and batching temperatures remained the same for both fiberous and non-fiberous mixtures. (Refer to Table 1 for mix design data.)

All batch plant production gradation analysis indicated that both the fiberous and non-fiberous mixtures were produced within specification ranges. (Refer to Table 1).

No special paving or compaction procedures were needed to place the fiberous mixtures. Hand working the fiberous mixture around catch basins and manholes presented slight problems due to the tenacious characteristics of this type of mixture.

IV. PROJECT SAMPLING

Type 6F fiberous and non-fiberous mixture samples were obtained to determine Marshall test properties. Pavement cores were extracted in areas representing Type 6F fiberous and non-fiberous mixtures to determine the compactive properties of the pavement. Type 7 fiberous and non-fiberous material was not sampled. (Refer to Table 2 for test results).

Test data obtained from the project samples and pavement cores indicates that acceptable fiberous and non-fiberous Type 6F mixture was produced. From the test data obtained, the following facts should be noted:

1. The fiberous mixture exhibited Marshall Stability values 13 percent lower than the non-fiberous mixture.

2. The fiberous mixture exhibited higher Marshall Flow values than the non-fiberous mixture.

3. The fiberous mixture exhibited higher Marshall and pavement core air void values than the non-fiberous mixture.

4. The fiberous pavement cores exhibited lower percent of Marshall Density values than the non-fiberous mixture. This is an indication that the fiberous mixture may be more difficult to compact.

V. SUMMARY

The experimental Fiberous Reinforced Bituminous Concrete mixture was placed on November 2 and 3, 1982.

Placing and compacting this type of fiberous mixture may require additional compactive effort in order to achieve acceptable pavement densities.

Bituminous concrete paving mixtures with 0.25 percent polyester fibers have the capability of meeting the Marshall Design Criteria.

Future plans are to monitor and evaluate this experimental test section throughout the pavement life to determine if the addition of polyester fibers is effective in reducing or eliminating pavement reflective cracking.

On February 9, 1983 a visual inspection was conducted on the fiberous pavement test section. There was no evidence of reflective cracking or deterioration observed at this time.

APPENDIX

FIGURE 1

FIBEROUS REINFORCED BITUMINOUS CONCRETE PROJECT
HEMPSTEAD TURNPIKE - ROUTE 24
NASSAU COUNTY - CONTRACT D250009

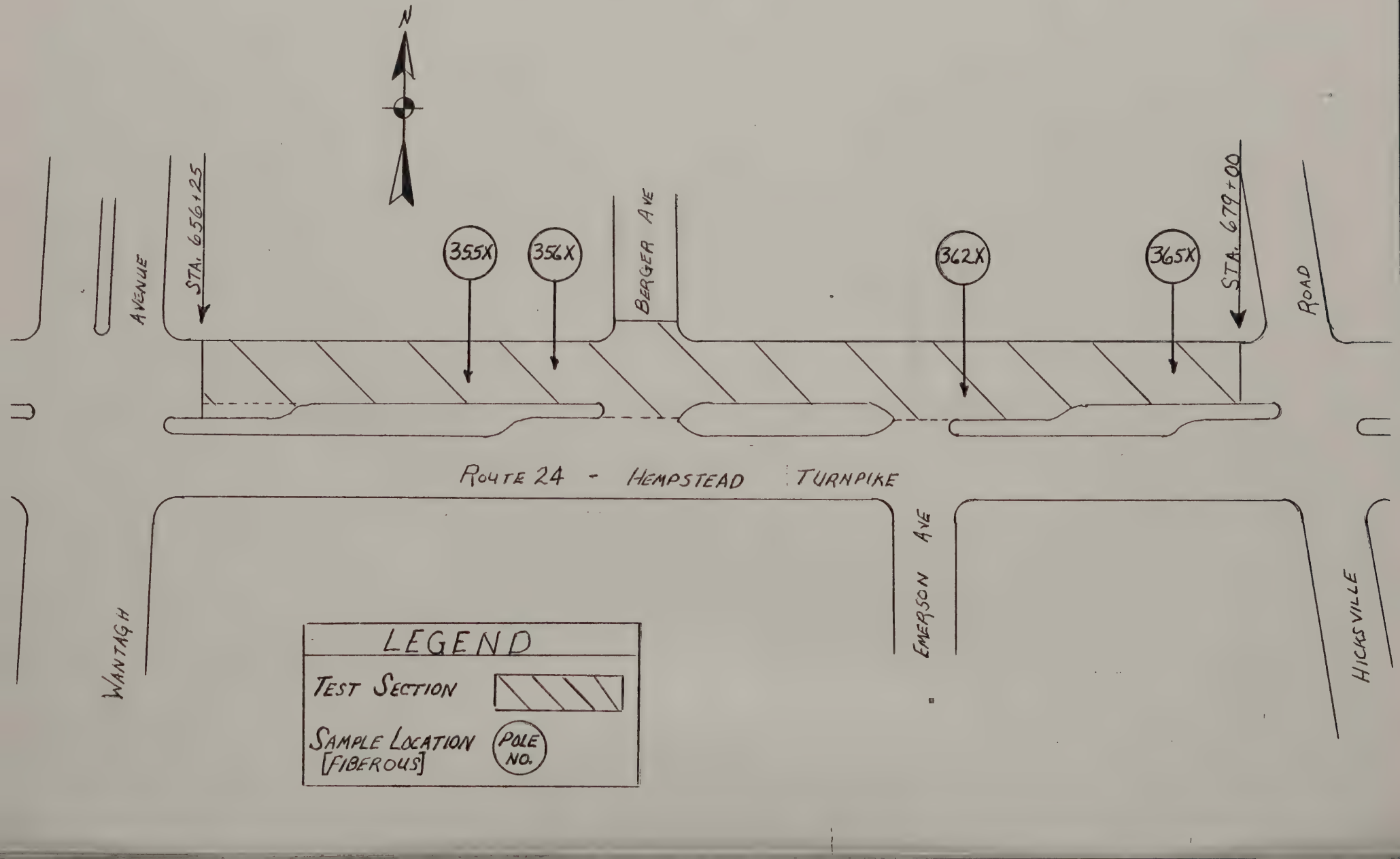
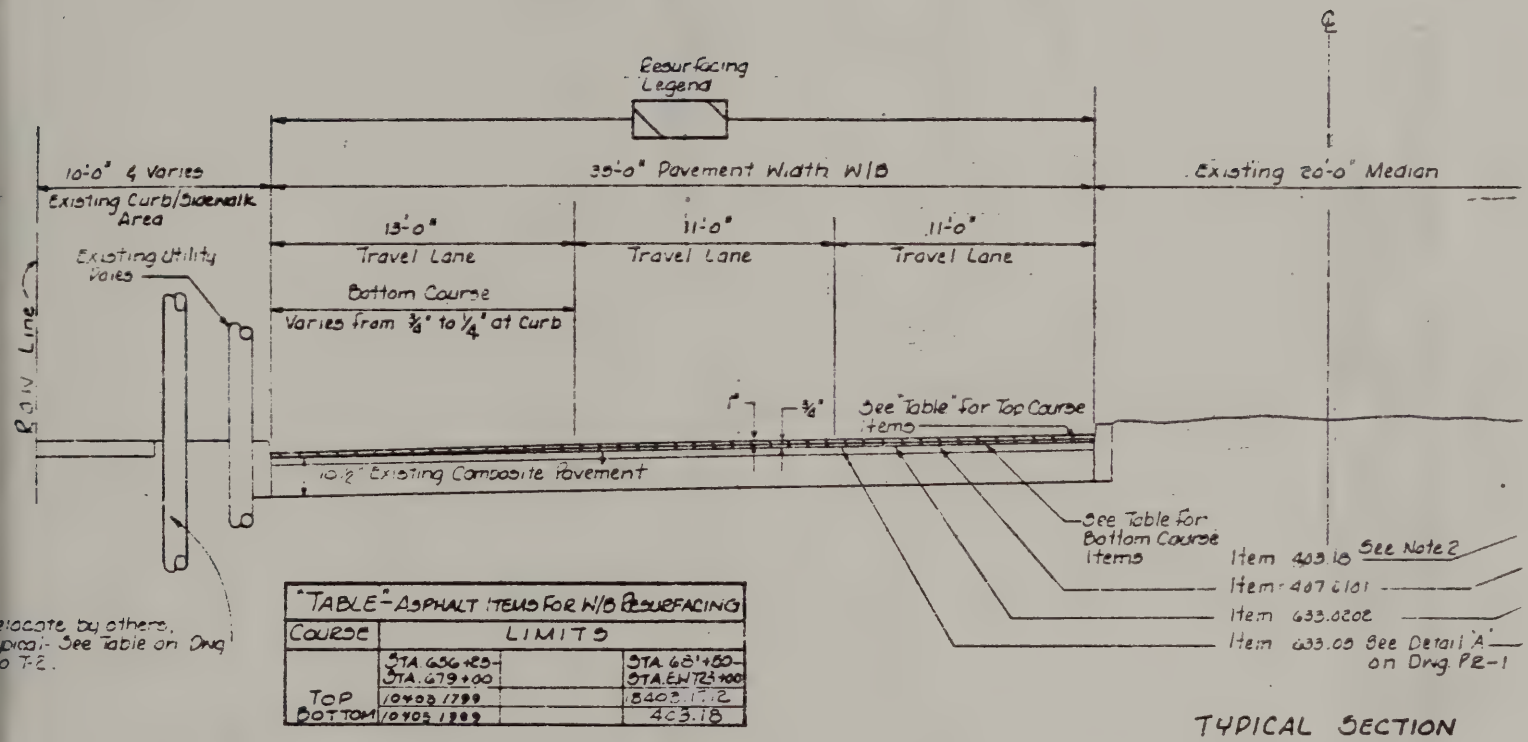


FIGURE 2
FIBEROUS REINFORCED BITUMINOUS CONCRETE PROJECT
HEMPSTEAD TURNPIKE - ROUTE 24
NASSAU COUNTY - CONTRACT D250009
TYPICAL SECTION OF TEST AREA



"TABLE" - ASPHALT ITEMS FOR W/B RESURFACING

COURSE	LIMITS		
TOP	STA 656+20 - STA 679+00		STA 68'+80 - STA EN 723+00
	10403.1799		10403.1702
BOTTOM	10403.1899		403.18

TYPICAL SECTION

FIGURE 3

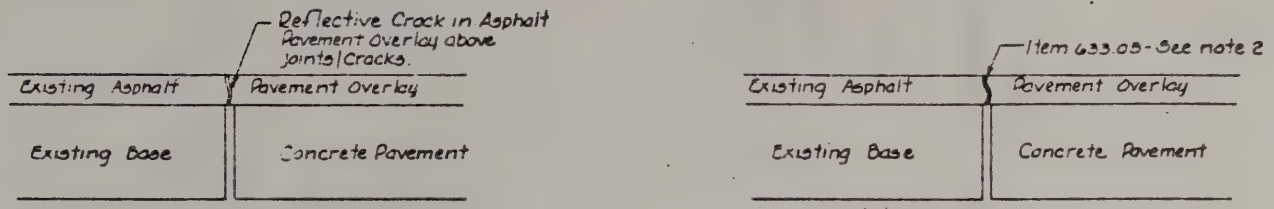
FIBEROUS REINFORCED BITUMINOUS CONCRETE PROJECT
HEMPSTEAD TURNPIKE - ROUTE 24
NASSAU COUNTY - CONTRACT D250009
TEST AREA - BEFORE OVERLAY

East end of test section - Looking West.

West end of test section - Looking East.

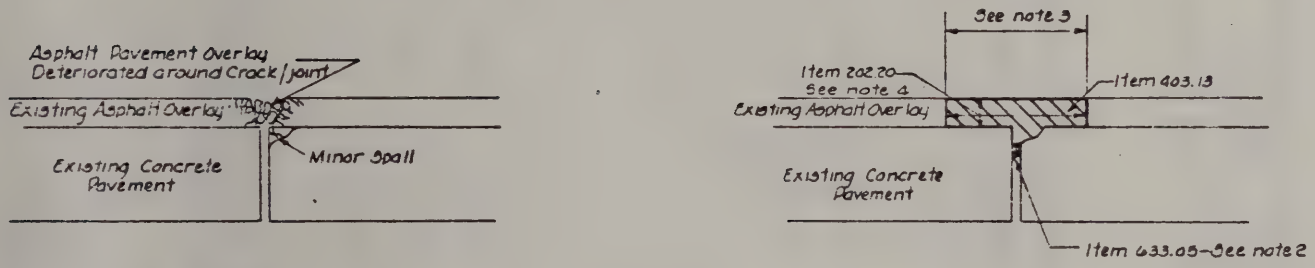
Near center of test area - Looking West.

FIGURE 4
FIBEROUS REINFORCED BITUMINOUS CONCRETE PROJECT
HEMPSTEAD TURNPIKE - ROUTE 24
NASSAU COUNTY - CONTRACT D250009

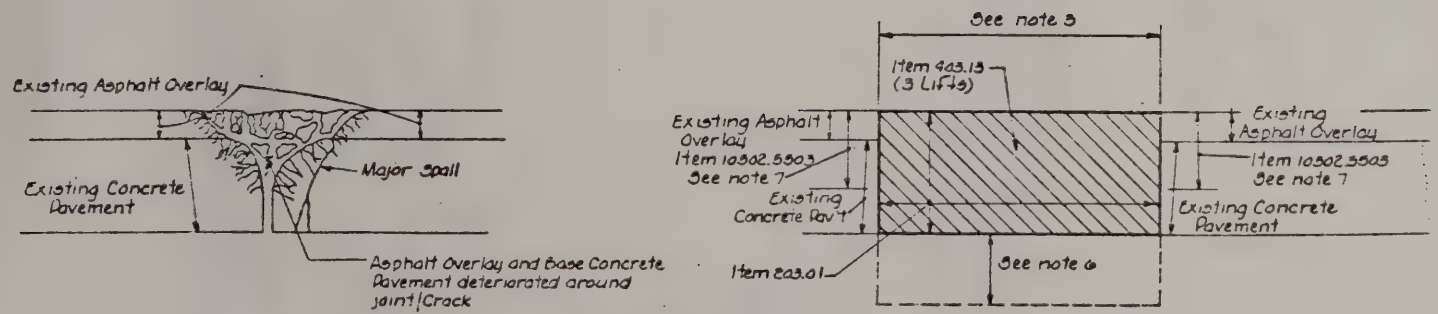


Type 'A' repairs shall not be done until Types 'B' and 'C' are completed

TYPE 'A'
Existing Composite Pavement Structurally Sound



TYPE 'B'
Asphalt Overlay Deteriorated
Base Concrete Structurally Sound
See note 3



EXISTING CONDITIONS

TYPE 'C'
Asphalt Overlay and Base Concrete Deteriorated

REPAIR TREATMENT

PAVEMENT REPAIR DETAILS
NOT TO SCALE

TABLE 1
FIBEROUS REINFORCED BITUMINOUS CONCRETE PROJECT
HEMPSTEAD TURNPIKE - ROUTE 24
NASSAU COUNTY - CONTRACT D250009
MIX DESIGN AND PRODUCTION TEST RESULTS

GRADATION ANALYSIS (Total Percent Passing)

Sieve Size	1"	1/2"	1/4"	1/8"	#20	#40	#80	#200	Asphalt Content
TYPE 6F (1)									
(Specification Range)	100	95-100	65-78	38-52	24-38	11-25	4-10	2-6	5.8 - 7.0
(Specification Target)	100	100	71.0	45.0	31.0	18.0	6.0	4.0	6.1 (6.3)(3)
(Production Value)	100	100	70.0	45.8	28.7	13.5	5.1	4.1	6.1 (6.3)(3)
TYPE 7(2)									
(Specification Range)	100	100	90-100	46-58	26-40	11-25	4-12	2-6	6.1 - 6.9
(Specification Target)	100	100	95.0	52.0	33.0	18.0	8.0	4.0	6.5 (6.7)(3)
(Production Value)	100	100	98.2	55.2	28.1	12.2	5.1	4.0	6.5 (6.7)(3)

Notes: (1) Type 6F gradations remained the same for both fiberous and non-fiberous mixes.
(2) Type 7 gradations remained the same for both fiberous and non-fiberous mixes.
(3) Asphalt content with the addition of polyester fibers.

TABLE 2
FIBEROUS REINFORCED BITUMINOUS CONCRETE PROJECT
HEMPSTEAD TURNPIKE - ROUTE 24
NASSAU COUNTY - CONTRACT D250009
PROJECT SAMPLE - TEST RESULTS

Mixture Type	Test Site Location	Temperature °F Air	Mixture		MARSHALL PROPERTIES Stability (lbs)	Flow 1/100"	Air Voids (%)	Bulk Density (lbs/cu. ft)	PAVEMENT CORE PROPERTIES Air Voids (%)	Bulk Density (lbs/cu. ft)	% Marshall Density
	365X	70°	305°		1886	14	3.12	151.25	7.15	145.08	
FIBEROUS	356X	70°	290°		1636	13	3.97	149.32	7.35	145.14	
Type 6F	362X	60°	310°		1629	13	4.19	149.76	7.96	143.97	
	355X	60°	280°		1674	13	4.71	148.89	7.73	144.58	
				AVE	1706	13	4.00	149.80	7.55	144.69	96.6
NON-	385X	65°	275°		1882	11	2.51	152.69	4.90	148.95	
FIBEROUS	383X	60°	305°		1776	11	2.37	151.69	3.85	150.55	
Type 6F	380X	60°	300°		2067	12	2.31	153.25	3.32	151.75	
	379X	60°	310°		2100	11	2.24	152.32	3.81	150.70	
				AVE	1956	11	2.36	152.49	3.97	150.49	98.7

NOTES:
1. All test site location numbers are Long Island Lighting utility pole numbers.
2. Mixture temperatures and samples were obtained at the paver.
3. For every test site location the Marshall Test Property values are the mean of three specimens.
4. For every test site location the Pavement Core Property values are the mean of two specimens.